Xanthomonas microbe associated molecular patterns (MAMPs)

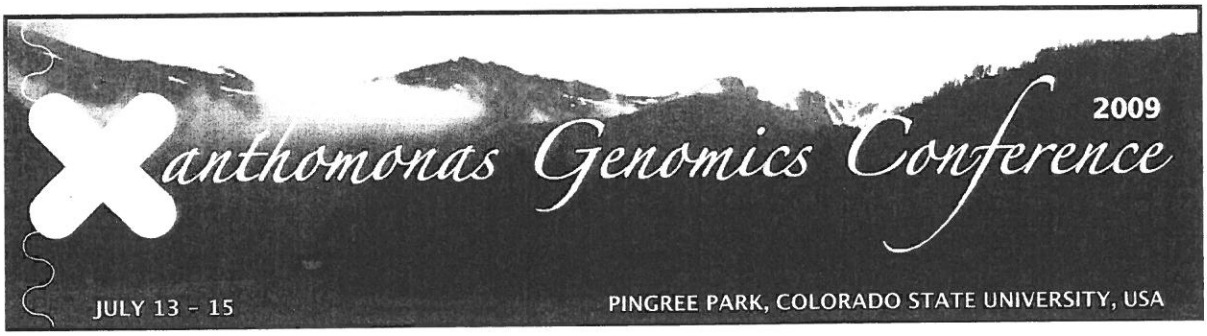
elicitors of Plant Innate Immunity

Erbs, Gitte; Aslam, Shazia; Molinario, Antonio; Dow, J. Maxwell; Cooper, Richard M.; Newman, Mari-Anne

Publication date:
2009

Document version
Publisher's PDF, also known as Version of record

Kris-Anne Newman



PROGRAM

ABSTRACTS

and

PARTICIPANT DIRECTORY

Session V Moderator Max.

Newman

Xanthomonas Microbe Associated Molecular Patterns (MAMPs): elicitors of Plant Innate Immunity

Gitte Erbs,[1] Shazia Aslam,[2] Antonio Molinaro,[3] J. Maxwell Dow,[4] Richard M. Cooper,[2] and Mari-Anne Newman[1]

[1]Faculty of Life Sciences, Department of Plant Biology & Biotechnology, University of Copenhagen, Denmark; [2]Department of Biology & Biochemistry, University of Bath, U.K.; [3]Dipartimento di Chimica Organica e Biochimica, Università di Napoli, Napoli, Italy; [4]BIOMERIT Research Centre, National University of Ireland, Cork, Ireland.

1

Plants perceive several general elicitors from both host and non-host microbial pathogens. These microbe-specific elicitors are essential structures for pathogen survival and are for that reason conserved. They are referred to as Microbe or Pathogen Associated Molecular Patterns (MAMPs or PAMPs) and are recognised by the plant innate immune system. We have chemically and biologically examined peptidoglucan (PGN) from two Gram negative plant pathogens, *Xanthomonas campestris* pv. *campestris* (Xcc) and *Agrobacterium tumefaciens* (At). We show that PGN functions as a MAMP in plants by triggering diverse innate immune responses, and that its perception is dose dependent. Clear differences in the structures of Xcc and At PGNs and their constituent muropeptides were found and may explain why Xcc PGN was a better elicitor of plant immune responses than At PGN; the lower efficacy of At PGN might relate with its subtle, biotrophic mode of invasion. However, for both bacteria the muropeptides were more effective in triggering immune responses in *Arabidopsis* than the native PGN. These findings demonstrate for the first time that PGN from true plant pathogenic bacteria functions as a MAMP. We have investigated the role of Xcc lipopolysaccharide (LPS) in plant innate immunity for a number of years. Here we present new data to show that *Arabidopsis* PEN1, a SNARE protein believed to be required for docking and fusion of intracellular transport vesicles, is involved in signal transduction leading to the induction of the innate immune responses by particular bacterial MAMPs. Specifically we show that PEN1 is required for induction of *PR1* gene induction, callose deposition and generation of reactive oxygen species by LPS but not by flagellin. These findings, which suggest multiple roles for PEN1 in determining plant resistance to pathogens, will be discussed in the light of previously published work that shows internalisation of LPS on application to suspension cultured cells.

Cooper

Xanthomonas oligomers and polymers: the complexity of elicitation and suppression of host innate immunity

Richard M. Cooper,[1] Shazia, N. Aslam,[1] Gitte Erbs,[2] Kate L. Morrissey,[1] Delphine Chinchilla,[3] Thomas Boller,[3] Antonio Molinaro,[4] Robert W. Jackson,[5] Marc R. Knight[6] and Mari-Anne Newman[2]

[1]Department of Biology & Biochemistry, University of Bath, BA2 7AY, U.K.; [2]Faculty of Life Sciences, University of Copenhagen, 1871 Frederiksberg, Denmark; [3]Zurich-Basel Plant Science Center, Botanical Institute, University of Basel, 4056 Basel, Switzerland; [4]Dipartimento di Chimica Organica e Biochimica, Università di Napoli, Complesso Universitario Monte SantAngelo, 80126 Napoli, Italy; [5]School of Biological Sciences, University of Reading, Berks RG6 6AJ, U.K.; [6] School of Biological & Biomedical Sciences, Durham University, Durham DH1 3LE, U.K.

2

Xanthomonas spp. produce the complex extracellular polysaccharide (EPS) xanthan, which is required for virulence of several major pathovars. The biosynthetic *gum* genes are characterized and evident in all *Xanthomonas* genomes. Protective functions are known, but we reveal a more fundamental role, that of suppression of MAMP-induced innate immunity. Polyanionic xanthan chelates calcium ions and levels of *X. campestris* xanthan in the apoplast are well in excess of that required to deplete this key calcium pool. Xanthan prevented or reduced calcium influx to the cytosol and the consequent signalling cascade, which is a prerequisite for defence activation. This was shown by comparing induction of various defence components (Ca influx, oxidative burst, callose formation, defence genes) by wild type and xanthan-deficient mutants and by inoculating pure xanthan prior to mutants or bacterial MAMPs. Infiltrated pure xanthan mimicked ultrastructurally the biofilm formed during infection. We also examined effects of MAMP combinations and their interactions with the host cell wall. Early responses in *Arabidopsis*, elicited by non-saturating concentrations of flagellin peptide (flg22), elongation factor peptide (elf18), *X. campestris* peptidoglycan (PGN) and constituent muropeptides, lipo-oligosaccharide (LOS) and core oligosaccharides, revealed that some MAMPs have additive and even synergistic effects, while some mutually interfere. The peptide elicitors are potent at sub-nm levels, whereas PGN and LOS only at high µm levels induce low and late responses. This contrast may result from restricted access to receptors through the host wall of these macro-molecular MAMPs. Thus flg22 rapidly permeates a cell wall matrix, whereas LOS, which forms micelles, is severely constrained. Clearly, induction and suppression of innate immunity involves complex interactions between host and pathogen polymers.